

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

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(ACCELEROMETER).

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DESCRIPTION OF THE KLEMPERER WING STRAIN METER
(ACCELEROMETER).*

The wing strain meter is an instrument which has long made its proofs in practical experiments and has its place marked on the instrument board as indispensable for letting the pilot know the strain on the lifting surfaces and warning him of the safe limits which may not be exceeded. The instrument measures 0.85 mm. in diameter and weighs 365 grs. plus 175 grs. for a spring suspension.

It does not need to be observed continually. A glance of the pilot at sharp curves or the beginning of a dive is sufficient to know what the strain is. The intuitive judgment of strain is difficult to attain and is never very reliable, but the use of the wing strain meter helps to build up intuition. But even when the pilot is able to rely on his judgment he will still, for greater surety, glance occasionally at the instrument, especially when piloting a large or giant airplane. For sporting flights and stunting, the instrument is indispensable whenever great reliability is required. It is especially useful, however, to aircraft manufacturers and experimental laboratories where very accurate wing strain measurements are necessary in order to test the calculated strength of the airplanes and to know the controllability.

In wing strain the most important factors are the force of gravity and the force of lift which gives the measure of the sus-

* Translated from the German by Paris Office. Information supplied by Carl Zeiss, Jena.

taining force, and their components are perpendicular to the lifting surfaces. The sum of these components are measured by the wing strain meter near the center of gravity of the airplane.

The scale is divided equally from 0.5 to 3.5. When the airplane is at rest, that is when it is in equilibrium, or when it is in normal, straight horizontal flight, the simple strain 1 is shown. The other signs give the ratio of the respective strain to the unit. From the figure 2 a red strip appears on the scale and from 3 the whole field is red. The red first appears when the pointer is at 1.3. Up to that point the pilot does not need to pay any attention to strain. In sharp curves great strains appear and as previously stated, the figure 3 is easily reached.

Immediately the strain occurs the indication appears, for the movements of the device are well coordinated. The apparatus is suspended from a spring and is so built that it is not affected by ordinary starting and landing shocks. It is advisable, however, to keep the lower button in the "fixed" position in starting and landing. A screw covered with a protecting cap serves for placing the pointer at 1 when the airplane is in equilibrium.

Method of Using the Wing Strain Meter.

The airplane must be placed in equilibrium before the instrument is mounted. It is then attached to the instrument board or on the body in front of the wind screen in such a manner that the shutter has full play. When starting, the lower knob is placed at "fixed"; when fairly started it should be set at "free." When

red is seen (pointer between 1.3 and 2) no notice need be taken; when the red shows near the pointer (pointer between 2 and 3) no stronger force should be used on the elevator. When from the pointer on, the whole of the scale is red (pointer at 3), danger is at hand, and the pilot must therefore force his way out of such a position, or if the elevator is acting, reduce its action.

In sharp curves, where the lifting surfaces have to bear stresses arising from centrifugal force as well as those arising from the force of gravity, increased strain occurs (for instance the pointer will be at about 1.4 for a horizontal curve without slipping back when an angle of 45° is reached); with very sharp horizontal curves the pointer may mark from 1.6 to 2 and even more. The pointer does not move so long as the curve is described without loss of velocity. Steering close in increases it, contrary steering, that is in a direction contrary to the warping of the wing, decreases it, at least at first.

In taking off, the stress first increases but this only continues until the more inclined position of the airplane diminishes the speed. In taking off under low power we get from 1.3 to 1.5. In a very quick take-off we may easily get 2 immediately and have a complex strain.

In steep curves, especially after a dive, we get the greatest strains. They may easily reach values of about 2, and in sudden maneuvers the pilot may be in serious danger of wing collapse.

In steady climbs the strain on the wings is rather less than

in horizontal flight, since a part of the strain is borne by the propeller. Usually the values are from 0.8 to 0.9.

In a glide, whether with power off or on, the strain is also somewhat below normal, about 0.9, because in that case part of the weight is balanced by the head resistance of the fuselage, etc.

In looping, the strain mounts at the beginning, is diminished at the top, and in the latter part of the loop, where the centrifugal force no longer acts, the strain is small, in a rapid loop about 0.6. In a slow loop in which the pilot "describes a belt" it is even negative. Finally, in coming out of a dive we have again an increase in strain in proportion to the suddenness of the elevator action. After a steep dive especially, the strain may increase and the danger of wing breakage is averted by the use of the instrument.

In side slipping in a straight flight the strain is reduced, for the wings do not bear the whole weight, the airplane slipping bodily.

In gusts the actual strains caused by the wind are shown instantaneously. Light gusts give rise to strains of 1.2 and upwards. Heavier gusts causing double the amount of strain, have previously been studied, though chiefly with a view to discovering how the pilot could best reduce the amount of strain by expert use of the controls. The wing strain meter shows in every case just what is the safety of the airplane from breakdown as regards the lifting surfaces. It follows therefore that in a vertical

dive in which the danger arises not from the lifting surfaces but from the control surfaces, the danger is not indicated on the wing strain meter. This however is of no importance, for in this case the danger is signaled by the speed indicator.

In soaring flight experiments the wing strain meter is of especial importance. It is one of the most reliable means of knowing whether a dynamical soaring maneuver can be used in a gust.

If after long use the pointer requires to be readjusted, the protective cap is taken off and the screw is loosened with a screwdriver until the pointer is properly adjusted.

Translated by N.A.C.A., Paris Office.

